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Taking on Storm Water

NESDI Program Addressing Immediate Needs, Testing Solutions & Gathering Knowledge

NAVY STORM WATER managers are taking on the removal of pollutants found in storm water generated at industrial installations. Runoff from industrial areas contains heavy metals, suspended solids, and oil and grease at levels that can exceed National Pollutant Discharge Elimination System (NPDES) permit limits and benchmarks. These pollutants are known to impair our nation's water bodies.

Runoff from industrial galvanized roofs and copper gutter systems add to the problem. Permit requirements vary by receiving water body and state, with some being more stringent than others. Storm water managers might have as many as 100 or more storm water outfalls to address. Space, slope and water table constraints can limit structural treatment solutions available to meet the NPDES requirements.

The U.S. Environmental Protection Agency (EPA) has initiated a national rulemaking to strengthen its stormwater program. EPA intends to propose a rule in September 2011 and take final action by November 2012. It is anticipated that the rule could result in lower storm water permits

limits to which compliance will become an increasing challenge within the Navy.

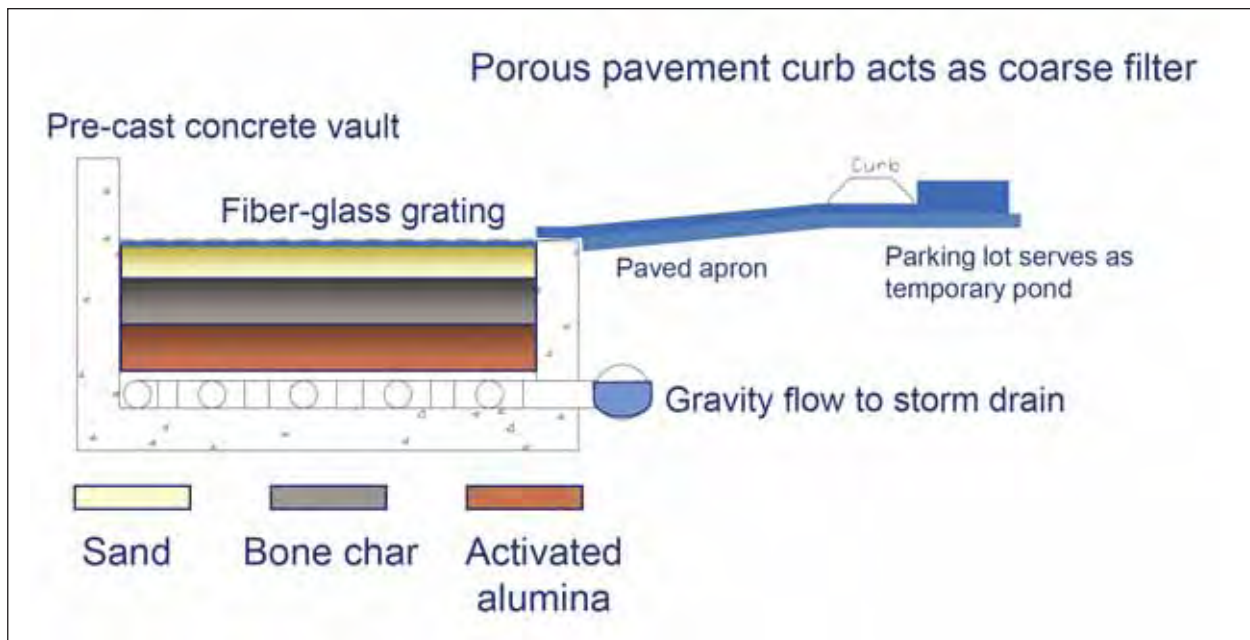
The Navy Environmental Sustainability Development to Integration (NESDI) program receives multiple requests each year to help storm water managers improve storm water compliance. To address these challenges, the NESDI program has provided resources to personnel from the Naval Facilities Engineering Command Engineering Service Center (NAVFAC ESC) and other organizations to demonstrate and validate commercially available systems and new systems as possible Best Management Practices (BMP) to maintain pollutant concentrations below permitted levels. Recent projects include the demonstration of a below grade dual media filtration system, a roof runoff BMP, and an above grade linear treatment known as the Linear Treatment System (LTS). NAVFAC ESC has also evaluated over 25 absorbent media aimed at removing copper and zinc, which are known to be toxic at low concentration to some marine organisms. In addition to evaluating above and below ground systems, the NESDI program has supported

efforts to evaluate non-structural or administrative techniques, optimize existing BMPs and develop a web-based tool to assist water program managers in selecting the most appropriate BMP.

The recent demonstration of the LTS at the Naval Regional Recycling Center (NRRC), San Diego, CA, offers insights into the NESDI program's expedient approach to addressing current needs while concurrently testing for broader applications. One of the objectives of the LTS project was to improve the performance and the maintainability of the existing, below-grade BMP by reducing the sediment load that tends to plug the absorbent media. A broader objective was to determine if the above-ground LTS could be used to control dissolved metal contaminants found in sheet flow (i.e., non-point) storm water runoff.

Background

All industrial activities, including those operated by the Navy, are under increasing pressure from EPA, state regulators and local communities to reduce the concentration of pollutants found in storm water runoff from being discharged into harbors, bays,



Cross-section of Storm Water Runoff Treatment System.



lakes and streams. Contaminated sediments can pose a substantial threat to aquatic life, wildlife, fisheries and human health. Fish and bottom-dwelling creatures suffer disease, death, reproductive failure or impaired growth upon exposure. Trace metals (e.g., copper, mercury, zinc) in the sediments are harmful particularly because they persist in the marine environment and bio-accumulate up the food chain, traveling from marine organisms to fish then to humans.

Storm water runoff from Navy industrial operations can be roughly characterized as having elevated metals content, moderate suspended solids and organic content, and low nutrient and bacteria content. The

elevated metal concentrations in storm water runoff from Navy industrial sites can be attributed to outdoor metal working processes such as cutting and grinding, outdoor storage of metal objects and use of metal bearing materials such as corrosion inhibiting and anti-fouling paints. Suspended solids are usually fine particles of soil deposited on the watershed by wind or erosion. Dust created by industrial processes (such as media blasting) is another source of fine particles. Organic material can often be attributed to small leaks of motor oil, hydraulic fluid and antifreeze.

Recognizing that Navy industrial sites typically have limited land area for storm water BMPs, as well as limited resources, the NESDI program's ideal storm water treatment system concepts strive to meet the following criteria:

- Low capital cost
- Easy installation
- Minimum land area requirements
- Low maintenance frequencies and costs
- Site-specific permit requirements compliance.

Some of the previously demonstrated technologies, funded by the NESDI program, include:

- Full scale dual media storm water treatment trench BMP

- Full scale roof runoff BMP
- Storm Water BMP Decision Support Tool web site to assist storm water managers in selecting optimal BMPs to meet NPDES permit limits.

Dual-media Filtration System

This filtration system is a below-grade structural BMP, designed to remove dissolved copper and zinc from storm water runoff at NRRC. The NRRC was required to meet California Regional Water Quality Control Board (CRWQCB) requirements to pass a 96-hour acute toxicity test, reduce copper discharges to less than 63 micrograms per liter ($\mu\text{g/l}$), and reduce zinc discharges to less than 117 $\mu\text{g/l}$. At this project's initiation, Commercial Off-the-Shelf (COTS) technologies were expensive, costing approximately \$57,000 or more per acre of drainage. The existing COTS technologies also were not reliably passing required toxicity tests.

The NESDI program sponsored the development and integration of a lower cost innovative two-stage filter process that utilizes filtering and adsorption media (bone char and activated alumina) to filter out solids and metals. The installed system had a significantly lower capital cost (\$20,000 per acre of drainage), low operational cost and required little land area. For more information about this system, see our article entitled "Treatment of Storm Water Runoff from Military Industrial Activities: NFESC Demonstrates Advanced Storm Water Runoff Treatment System" in the winter 2006 issue of *Currents*.

Roof-top/Downspout Filtration System

Roof-top runoff from Building V-88 on Naval Base Norfolk appeared to be contributing elevated copper and

zinc concentrations in storm water samples. The building has a galvanized metal roof and copper gutters and downspouts.

Drawing from the successful implementation of the dual media BMP, NAVFAC ESC incorporated components into a new BMP technology to address roof-top runoff in Norfolk, VA. The BMP is a 200-gallon barrel filled with bone char layered over activated alumina, with geofabric and an internal drain system, to capture heavy metals in the Building V-88 downspout runoff. The BMP removed enough copper and zinc from the storm water to meet the Virginia

Roof-top Runoff BMP.



The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside 6.4 Research, Development, Test and Evaluation program. The NESDI technology demonstration and validation program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division (N45) and managed by NAVFAC. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Leslie Karr, the NESDI Program Manager at 805-982-1618, DSN: 551-1618 or leslie.karr@navy.mil.



SUMMARY OF PERFORMANCE OBJECTIVES

Performance Objective	Metric	Data Requirements	Success Criteria	Actual Performance Objective Met?
Quantitative Performance Objectives				
Reduce TSS	EPA 2540.D test method	Influent and effluent TSS concentration	80% reduction	No
Reduce Dissolved Copper and Zinc	EPA 200.8 test method	Influent and effluent metals concentration	75% reduction	Yes
Maximize Hydraulic Capability	Flow conductivity	Bench scale testing at constant head, gallons per minute (gpm)	2–4 gpm per linear foot	Yes
Qualitative Performance Objectives				
Lower O&M Cost	Annual maintenance cost Replacement/disposal cost	Replacement cost and cleanup man-hours	< Below grade COTS and O&M costs	Yes
Minimize Degradation	BMP durability	Qualitative observation of rips, clogs, and undesirable movement	Minimum of one year's performance	Yes

storm water screening criteria of 33 µg/l copper and 180 µg/l zinc.

The Roof-top Runoff BMP provides Naval Base Norfolk with a lower cost decentralized method of meeting their Virginia Pollutant Discharge Elimination System storm water discharge requirements. The BMP sampling results indicate that several small-scale structural BMPs can be deployed at building downspouts (and other point sources of copper and zinc) in lieu of larger, centralized treatment systems for storm water runoff.

The Storm Water BMP Decision Support Tool Web Site

The NAVFAC ESC also developed a web-based expert system, the Storm Water BMP Decision Support Tool, which is designed to help users identify the most cost effective storm water BMPs to address storm water run-off requirements at Department of Defense (DoD) installations and activities. The BMP website is based on a review of proven BMPs and lessons learned from past and ongoing BMP projects performed by

the DoD, government and the private sector. The website ties BMPs to Navy specific industrial operations, site conditions and discharge limits. The BMP website address is: www.p2sustainabilitylibrary.mil/stormwaterbmp/hm.html

Experiments with a Linear Treatment System

When the NRRC storm water BMP was showing signs of reduced flow, the NAVFAC ESC team looked for an expedient approach that would offer a quick response to an immediate need while also offering an opportunity to test additional non-structural BMPs for potential as stand-alone, above grade use.

The NRRC is one of the Navy's recycling centers that accepts used and scrap materials, such as metals, paper, cardboard and plastic, for recycling and resale. The center currently uses a full scale, structural dual media filtration system to remove toxic metals from the storm water runoff. Although the system is working, fine particle solids (silt) are prematurely plugging the filtration system, which

leads to increased maintenance and reduced effectiveness. Some method of pre-treatment was needed to optimize the existing system. The site also offered other advantages for conducting tests, including on-site sampling equipment and nearby power to run the equipment.

The NAVFAC ESC team looked for existing BMP techniques that might be adapted to this need. One BMP technique often used at new construction sites is to place straw wattles (rolls) to capture suspended solids in storm water runoff. Working with this concept, the NAVFAC ESC team developed a bench-scale apparatus to evaluate multiple combinations of adsorptive media within fiber rolls. Each combination was tested for Total Suspended Solids (TSS) filtration and dissolved metals removal efficiencies, as well as the hydraulic capabilities. Qualitative measures included operation and maintenance costs and system durability. (See table above.) The test performance objectives were based on NPDES standards for discharge to San Diego Bay.

CANDIDATE MEDIA TYPES

Organic Materials	Active Materials	Inert Minerals	Proprietary Materials	Other
Loose peat moss	Activated alumina	Perlite	Forager sponge cubes	Iron chips and filings
Hardwood chips	Iron Coated activated alumina	Washed plaster's sand	Dynaphore granules	Sodium alginate beads
Bone char	Zeolite (chabasite)	Washed concrete sand	Ancor M-20/80 zero valence iron	Geotextile
Anthracite	Zeolite (glauconite)	Washed well- packing gravel	Stormwater Management Metal Rx	Ecology Mix
Sulphonated peat moss	Ilmanite		Environmental H ₂ O, LLC White Karbon	

The table above lists media considered for preliminary testing.

The laboratory scale apparatus and set-up schematic are shown in Figures 1 and 2.

In this testing, each media type was tested in a wattle (or roll) for both hydraulic capabilities and TSS and dissolved metals removal efficiencies. Both are important to overall success.



FIGURE 1: Laboratory scale test bed.

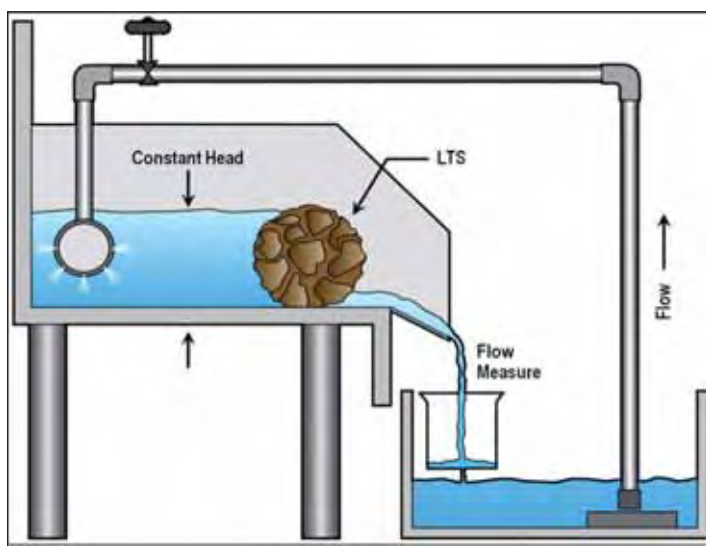


FIGURE 2: Schematic of laboratory scale testing.

The hydraulic capability of a LTS is dependent upon the characteristics of the internal filter media. The important characteristics include: particle size, particle shape, particle gradation, hydrophobicity and the degree of compaction.

Figure 2 displays the hydraulic capability test setup. Wattle hydraulic capabilities were measured for each test candidate by regulating flow with a control valve until a constant head steady state flow was achieved. The test results could then be compared on a flow rate per inch of head relationship, and also be expressed as gallons per minute (gpm) per linear foot of LTS.

The TSS and dissolved metals removal efficiencies were then measured by moving the sump pump shown in Figure 2 to a separate tank with a known influent concentration of TSS, copper and zinc. Influent concentrations of copper and zinc were chosen using historical storm water characterization data from previous NAVFAC ESC projects conducted at the NRRC site.

The laboratory-scale testing showed one of the linear treatment systems was capable of removing significant levels of total suspended solids and dissolved copper and zinc from a synthetic storm water solution. The linear treatment system had 79 percent removal efficiency for total suspended solids and dissolved copper and zinc. The laboratory scale results exceeded the 75 percent dissolved metals quantitative performance objective, and were just one percentage point below the 80 percent TSS quantitative performance objective.

The hydraulic capacities of the most promising adsorption medium, however, were inadequate for the NRCC site. Flow rates less than the two gpm per linear foot threshold would likely cause excessive flooding at the site. Efforts to optimize the hydraulic capacity resulted in reduced removal efficiencies.

How to Submit a Need to the NESDI Program

FOR THE NESDI program, a “need” defines a requirement to eliminate or reduce an environmental constraint that:

- Addresses a Fleet operational challenge
- Identifies an existing gap in knowledge, technology, and/or capability
- Is associated with an environmental constraint or regulatory driver

Needs are the fundamental basis of the NESDI program as all of its technology investments are based on recommended solutions to the need.

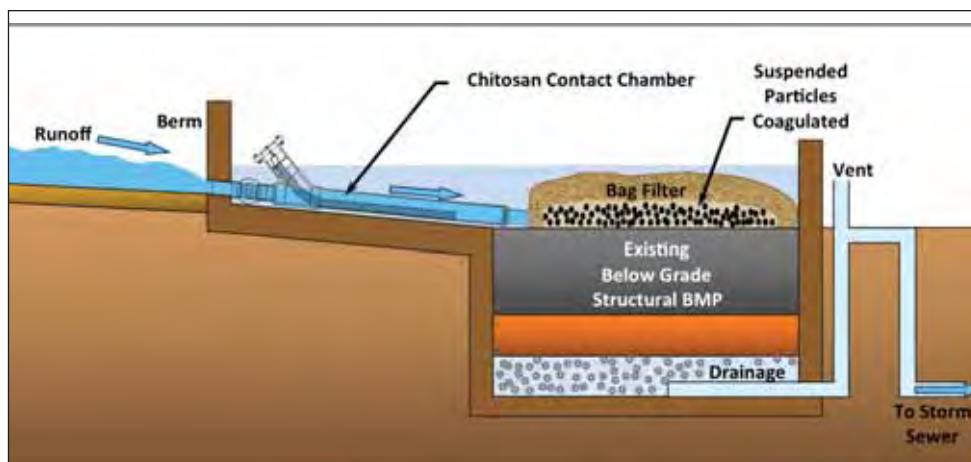
To submit your need, visit the “Environmental Needs” section on the NESDI web site then click on the “Submit A Need Now” button. This will take you to the “NESDI Environmental Needs Submission Form.” Use this on-line form to characterize your need. Then click on the “Submit Need” button to complete the process.

Once you submit your need, technical experts assembled by NESDI program management will assess, validate, and rank it. You will be notified about the ultimate status of your need once this ranking process is complete. For more information, download the *Reference Guide: Submitting and Evaluating Needs* by visiting the NESDI web site at www.nesdi.mil then clicking on the “Environmental Needs” button.

Although none of the LTS combinations could simultaneously meet all performance objectives for a stand-alone BMP using the stringent standards required for San Diego Bay, the high metals removal efficiencies of selected materials show promise for other applications and possibly for other locations. Other industrial sites might be able to

use the filter wattle depending on site-specific permit requirements and hydraulic conditions.

Using results from this LTS demonstration, the NESDI program initiated a subsequent project to develop a low maintenance retrofit to the existing below-grade BMP to improve its performance. The objective of the new project is to include a pre-filtering system to remove particularly fine suspended solids from industrial site storm water runoff. These types of solids have



Schematic of filtration BMP for optimizing a dual media system.

increased maintenance demands and diminished the system’s performance reliability for meeting permit requirements.

The current project, *Optimization of the Storm Water Dual Media Filtration System at NRRC San Diego*, will test the effectiveness of a low-maintenance filter sock mesh containing flocculating material placed immediately upstream of the structural BMP.

Such a filtration add-on could enhance the performance of any below-grade

structural BMP. If successful, this technology will significantly decrease the frequency of labor-intensive maintenance while allowing industrial facilities to consistently meet NPDES permit requirements. ⚓

Photos by Gary Anguiano

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